IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicants	:	N. YOSHINAGA, et al.
Appln. No.	:	10/574,053
Filed	:	March 29, 2006
Examiner	:	Mark L. Shevin
Art Unit	:	1793
For	:	HIGH YIELD RATIO AND HIGH-STRENGTH THIN STEEL SHEET SUPERIOR IN WELDABILITY AND DUCTILITY, HIGH YIELD RATIO HIGH-STRENGTH HOT-DIP GALVANIZED THIN STEEL SHEET, HIGH YIELD RATIO HIGH-STRENGTH HOT-DIP GALVANNEALED THIN STEEL SHEET AND METHODS OF PRODUCTION OF SAME
Conf. No.	:	7701

Commissioner for Patents
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DECLARATION UNDER 37 C.F.R. §1.132

I, Naoki Yoshinaga, hereby declare and state as follows:

1. I am a co-inventor of the above-identified patent application, which has been assigned to Nippon Steel Corporation, Tokyo, Japan. I have been employed by Nippon Steel Corporation since 1988, and my current position is Director of Kimitsu R&D Laboratory. I graduated from Ghent University, Belgium, with a Doctoral degree in Applied Science in 1999.

2. I have reviewed the Office Action mailed February 1, 2011, and the references cited therein, *i.e.*, U.S. Patent No. 6,364,968 ("Yasuhara"), Japanese Patent Publication 2000-080440 ("Tosaka"), and Japanese Patent Publication 2003-193194 ("Fujita"), and Marder, Vol. 20 of ASM Handbook (1997), pages 1 to 10 ("Marder"). I have also reviewed the specification and the pending claims of the present application.

3. I understand that the Examiner is of the opinion that Yasuhara, Tosaka, or Fujita discloses steel sheets having steel compositions and properties overlapping those of the present invention and produced by similar processes, thus establishing a *prima facie* case of obviousness.

4. High strength steel sheet having good workability is important in many technical fields, including automobile manufacturing, e.g., making automobile frame (see, e.g., the specification at page 1, line 20 through page 2, line 22). One of the most important properties of a steel sheet for use in such fields is its spot weldability. For example, the strength of the spot weld zone remarkably falls and becomes uneven when welding current enters the expulsion and surface flash region (see, e.g., the specification at page 1, lines 20-34; and page 3, lines 8-14). Controlling welding current during spot welding to always below CE (the welding current immediately before expulsion and surface flash) is difficult. Fluctuations of welding current during spot welding cause decrease in weld zone strength and quality. In addition to spot weldability, the yield ratio and workability such as ductility are also important (see, the specification at page 2, lines 7-22).

The present invention provides a cold-rolled steel sheet having a combination of high yield ratio, high-strength, and superior spot weldability and ductility. The steel sheet of the present invention is achieved by, *inter alia*, having a composition containing Si in a narrow range of 0.54 to 0.65%, satisfying equation (1) below

$$1.1 \leq 14 \times Ti\,(\%) + 20 \times Nb\,(\%) + 3 \times Mo\,(\%) + 300 \times B\,(\%) \leq 3.7,$$

and having a microstructure 85 area% of lower bainite or bainitic ferrite. The steel sheet has a yield ratio of more than 0.64 to less than 0.90, a TS x (E1)½ of 3320 or more, an YR x TS x (E1)½ of 2320 or more, and a maximum tensile strength (TS) of 780 MPa or more. When the minimum value of CTS (here CTS is the tensile load in a cross-joint test) among 10 values of CTS obtained by welding 10 test pieces by a welding current of CE (here CE is the welding current immediately before expulsion and surface flash) is defined as "1", the steel sheet of the present invention has a minimum value of CTS of 0.8 or more among 10 values of CTS obtained by welding 10 test pieces at welding current CE + 1.5 kA. The steel sheet further has an X-ray intensity ratio of a {110} plane parallel to the sheet surface at 1/8 the thickness of the steel sheet of less than 1.0.

The experimental data disclosed in the specification (Examples 5-7, Tables 6-8) and additional experimental data I obtained (Table I below) show the correlation between formula (1) and spot weldability, elongation and ductility. For example, Fig. A shows that steel sheets of a composition having formula (1) below 1.1 exhibit poor spot weldability, whereas Figs. C and D show that steel sheets of a composition having formula (1) above 3.7 exhibit poor elongation and ductility. The experimental data in Table I also show that when the steel sheet composition has a formula (1) below 1.1, the yield ratio is 0.59 (steel X-1), outside the range of more than 0.64 to less than 0.90 as required by the claims.

Table I Additional Experimental Data

	C	Si	Mn	P	S	Al	N	Ti	Nb	Mo	B	equation (1)	Remarks
X-1	0.061	0.62	2.16	0.008	0.0026	0.032	0.0028	0.011	0.021	0.11	0.0006	1.08	Comp. ex.
X-2	0.063	0.57	2.15	0.007	0.0029	0.026	0.0031	0.012	0.025	0.13	0.0007	1.27	Inv. Ex.
X-3	0.060	0.61	2.07	0.008	0.0025	0.027	0.0026	0.013	0.038	0.41	0.0032	3.13	Inv. Ex.
X-4	0.058	0.57	2.12	0.007	0.0027	0.035	0.0025	0.038	0.046	0.41	0.0035	3.76	Comp. ex.

	Maximum peak temperature, °C	Additional heat treatment temperature, °C	Skin-pass reduction rate, %	TS, MPa	YS, MPa	El, %	$TS \times El^{1/2}$	YR	$YR \times TS \times El^{1/2}$	{110}	Spot weldability	Remarks
X-1	840	400	0.7	1012	598	15	3920	0.59	2316	0.3	F	Comp. ex.
X-2	840	400	0.7	1063	673	15	3855	0.67	2614	0.3	G	Inv. Ex.
X-3	840	400	0.7	1055	834	13	3804	0.79	3007	0.3	VG	Inv. Ex.
X-4	840	400	0.7	1112	975	8	3145	0.88	2758	0.3	G	Comp. ex.

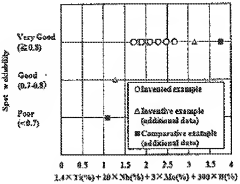

Fig. A

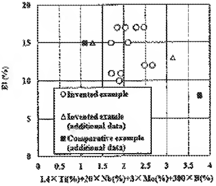

Fig. B

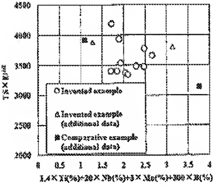

Fig. C

Figs. D and E show the correlation between X-ray intensity ratio of a {110} plane and rolling conditions in the present invention. As can be seen from Figs. D and E, the X-ray intensity ratio of the {110} plane is less than 1.0 for the cold-rolled steel sheets of the present invention, while higher than 1.0 for the hot-rolled steel sheets. In the present invention, the X-ray intensity ratio of less than 1.0 for the cold-rolled steel sheets is necessary for achieving desirable formability (see the specification at page 14, lines 11-20).

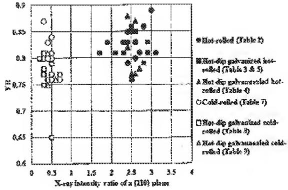

Fig. D

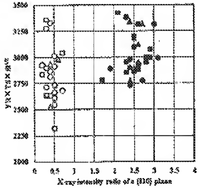

Fig. E

5. Yasuhara discloses a high-strength hot-rolled steel sheet having excellent stretch flangeability. Yasuhara does not disclose a cold-rolled steel sheet, because Yasuhara's steel sheet is not subject to cold rolling. The skin-pass rolling of the hot-rolled sheet used in Yashuhara (Yasuhara col. 13, lines 61-63) is different from the cold rolling of the present invention (reduction ratio 30 to 80%; see the specification at page 24, lines 31-33). A skin-pass rolling is also used on hot-rolled steel sheet in the present invention with a reduction ratio 4% (see the specification at page 20, lines 25-30). Thus, Yasuhara does not teach or suggest cold-rolled steel sheets.

Yasuhara is not concerned with spot weldability in the expulsion and surface flash region. Yasuhara does not teach or suggest maintaining weld zone strength when welding with a welding current of the expulsion and surface flash region. Yasuhara does not teach or suggest controlling alloy composition and formula (1) so as to achieve a steel sheet having the recited CTS in the expulsion and surface flash region.

I have also examined the examples of Yasuhara. Table II below shows that none of the examples disclosed in Yasuhara has a steel composition within the scope of the present invention.

Table II Comparison with Yasuhara[1]

	C	Si	Mn	Nb	Ti	Mo	B	equation (1)
1	0.08	0.10	2.7	0.04	-	-	-	0.80
2	0.08	0.25	2.3	-	0.08	-	-	1.12
3	0.08	0.15	2.9	0.005	-	-	-	0.10
4	0.06	0.80	2.5	0.009	0.055	-	-	0.95
5	0.35	0.20	1.5	0.18	-	-	0.0015	4.05
6	0.08	0.13	1.6	-	-	-	-	0.00
7	0.08	0.42	2.6	-	0.14	0.02	-	2.02
8	0.11	0.11	2.7	0.25	-	-	-	5.00
9	0.08	0.02	2.2	-	0.08	-	-	1.12
10	0.18	0.23	1.8	-	0.25	-	-	3.50
11	0.12	0.69	1.9	-	0.18	-	-	2.52
12	0.09	0.27	1.2	0.04	0.08	-	-	1.92
Our claim	*0.03 / 0.10*	*0.54 / 0.65*	*1.7 / 2.49*	*0.01 / 0.055*	*0.012 / 0.055*	*0.07 / 0.35*	*0.0005 / 0.0040*	*1.1 / 3.7*

6. Tosaka discloses a high-strength cold-rolled steel sheet having ≥780 MPa tensile strength and ≥70 MPa amount of baking hardening, excellent stretch-flange formability, spot weldability, delayed fracture resistance, and impact resistance. However, Tosaka is not concerned with spot weldability in the expulsion and surface flash region. Tosaka does not teach or suggest maintaining weld zone strength when welding with a welding current of the expulsion and surface flash region. Tosaka does not teach or suggest controlling alloy composition and formula (1) so as to achieve a steel sheet having the recited CTS in the expulsion and surface flash region.

I have also examined the examples of Tosaka. Table III below shows that none of the examples disclosed in Tosaka have a steel composition within the scope of the present invention.

Table III Comparison with Tosaka

[1] In Tables II-IV, grayed cells indicate that the values are outside the ranges of the present invention. Thus, an example is within the present invention only when none of the alloy content and formula (1) values is grayed.

	C	Si	Mn	Ti	Nb	Mo	B	equation (1)
A	0.08	*0.02*	*3.00*	-	0.045	-	-	*0.90*
B	0.08	*0.10*	*2.70*	-	0.040	-	-	*0.80*
C	*0.15*	*0.02*	*2.90*	0.015	*0.009*	-	-	*0.39*
D	0.08	*0.70*	2.00	-	0.025	-	0.0015	*0.95*
E	*0.15*	*0.25*	1.80	-	*0.009*	*0.02*	-	*0.24*
F	0.08	*0.03*	*3.10*	-	0.040	-	-	*0.80*
<u>G</u>	0.08	*0.15*	1.80	-	-	-	-	*0.00*
<u>H</u>	0.08	*0.02*	*1.00*	-	0.040	-	-	*0.80*
<u>I</u>	0.08	*0.02*	*2.80*	-	*0.100*	-	-	2.00
<u>J</u>	0.08	*0.02*	*3.80*	-	0.030	-	-	*0.60*
K	*0.18*	*0.05*	*1.60*	-	0.050	-	-	*1.00*
Our claim	*0.03 / 0.10*	*0.54 / 0.65*	*1.7 / 2.49*	*0.01 / 0.055*	*0.012 / 0.055*	*0.07 / 0.55*	*0.0005 / 0.0040*	*1.1 / 3.7*

Tosaka also uses a different production method. For example, Tosaka teaches reheating the cast slab to a temperature giving undissolved Nb 0.003% or more, preferably 1150 °C or less (Tosaka paragraph [0039]), whereas in the present invention the steel slab is heated to 1160 °C or more, preferably 1200 °C or more, more preferably 1230 °C or more (the specification page 23, lines 13-28). Tosaka also employs rapid cooling from the annealing temperature to a temperature region of 350 °C to over 200 °C at a cooling speed of 15 to 150 °C/s (Tosaka paragraph [0043]), whereas in the present invention, the average cooling speed from 500 to 600 °C is 5 °C/s or more (the specification at page 27, lines 4-8).

7. Fujita discloses a high strength, high ductility steel sheet having ≥800 MPa tensile strength and improved weldability and hole expandability. However, Fujita is not concerned with spot weldability in the expulsion and surface flash region. Fujita does not teach or suggest maintaining weld zone strength when welding with a welding current of the expulsion and surface flash region. Fujita does not teach or suggest controlling alloy composition and formula (1) so as to achieve a steel sheet having the recited CTS in the expulsion and surface flash region.

I have also examined the examples of Fujita. Table IV below shows that none of the examples disclosed in Fujita have a steel composition within scope of the present invention.

Table IV Comparison with Fujita

	C	Si	Mn	Ti	Nb	Mo	B	equation (1)
A	*0.12*	*0.74*	1.92		0.015	0.13		*0.69*
B	*0.19*	*1.21*	1.84		0.028	0.08		*0.80*
C	*0.18*	*1.12*	1.81		*0.011*	0.21		*0.85*
D	*0.11*	*0.68*	*1.65*		0.015	0.22		*0.96*
E	*0.18*	*0.98*	1.96		0.022	0.11		*0.77*
F	*0.13*	0.62	2.05		0.013	0.09		*0.53*
G	0.09	*0.45*	*1.69*		0.023	0.18		*1.00*
H	*0.11*	*0.98*	2.2		*0.008*	0.14		*0.58*
I	*0.21*	*1.3*	2.25	0.02	0.033	*0.01*		*0.97*
J	*0.14*	*1.03*	*1.56*		*0.009*	0.16	0.0025	1.41
K	*0.15*	*1.2*	1.95		0.026	0.14		*0.94*
L	*0.21*	*0.5*	2.45		0.042	*0.05*		*0.99*
M	*0.12*	*1.1*	2.23		*0.056*	*0.02*		1.18
N	*0.17*	*0.8*	2.12		0.021	0.2		*1.02*
O	0.09	*1.3*	1.95		0.032	0.16		1.12
P	*0.15*	0.6	1.78		0.015	0.31		1.23
Q	*0.14*	*1.2*	1.89		0.032	0.26		1.42
R	0.09	*0.9*	2.05		*0.011*	0.19	0.0012	1.15
S	*0.16*	*0.93*	1.87		0.033	0.17		1.17
CA	*0.18*	*1.5*	*1.4*					*0.00*
CB	0.07	*0.3*	2.3		*0.5*	*1.5*		*14.50*
CC	*0.13*	*1.5*	*1.68*	*0.81*			*0.25*	*86.34*
CD	0.06	*0.52*	*2.98*					*0.00*
CE	*0.22*	*2.65*	2.2					*0.00*
Our claim	*0.03 / 0.10*	*0.54 / 0.65*	*1.7 / 2.49*	*0.01 / 0.055*	*0.012 / 0.055*	*0.07 / 0.55*	*0.0005 / 0.0040*	*1.1 / 3.7*

The production methods of Fujita and the present invention are also different. For example, in the present invention, a heating rate of 10 to 30 °C/s is used in the annealing after cold-rolling (the specification at page 8, lines 3-6), whereas Fujita does not teach or suggest the heating rate. In addition, in the present invention, the cooling rate is 5 °C/s or more in the range of 500 to 600 °C (the specification at page 27, lines 4-8), whereas Fujita teaches a cooling rate of 1 to 150 °C/s to 500 °C or less (Fujita paragraph [0023]).

8. Based on the above discussion, it is my opinion that the cited references would not have led one of ordinary skill in the art to the steel sheet of the present invention.

* * *

I hereby declare that all statements made herein of my own knowledge are true, and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the

United States Code, and that such willful false statements may jeopardize the validity of the patent or any reexamination certificate issued.

Respectfully submitted,

7/26/2011
Date

Naoki Yoshinaga